

Lieutenant Colonel (Retd) K M Cook MBE

**Director, Project Development
Systems Design Evaluation Ltd**

**WEAPON MOUNTING SYSTEMS
SAFETY & SUITABILITY**

TASKS



- **Draft the Ordnance Board Formal Safety and Suitability Requirement Document for Cannon, AGL and SA Mounting Systems**
- **Draft Mount CPSs**
- **Conduct Safety and Suitability Assessments**
- **Test**
- **Produce Error Budgets**
- **Conduct Finite Element Analyses**
- **Support User Trials**

PRESENTATION OUTLINE

- **Summarise UK Ordnance Board Requirements**
- **Outline Testing Methodology**
- **Discuss the Use of Computer Modelling**

**UK ORDNANCE BOARD
PROCEEDING
124(1)**

**SMALL ARMS, CANNON AND
GRENADE LAUNCHER
MOUNTING SYSTEMS**

ALARP PRINCIPLE

- **A_s**
- **L_{ow}**
- **A_s**
- **R**easonably
- **P**ractical

SCOPE



- **Ground Mounts.**
- **Special Terrain Mounts (Such As A Snow Sled).**
- **Vehicle Mounts.**
- **Interface Mounts (Such As Soft Mounts, Cradles Or Yokes).**
- **Helicopter Door Mounts.**
- **Ship Or Small Craft Mounts.**

Detailed Information Provided

- Design Safety Principles and Requirements.
- Suitability for Service Requirements.
- Safety Test Requirements for Weapon Mounts.

Design Safety Requirements

- Mounting System Strength of Design
- Stability
- Locking Mechanisms
- Arc and Depression Stops
- Feed System
- Mechanical Triggers and Electronic GCU
- Ejection System

Design Safety Requirements



continued

- Applied Safety
- Human Factors
- Sights
- Toxicity
- Noise/Blast

Suitability Requirements

- Accuracy
- Consistency
- Firing Arcs
- Ejection
- Functioning
- Mechanical Reliability
- Functional Reliability

Suitability Requirements

Continued



- Durability
- Operational Factors
- Human/Handling Factors
- Maintenance
- Ammunition Supply

Safety Matrix

- Evidence Needed
- Service Environment Agreed By The User
- Technical Details of Mount
- Design safety Principles and Requirements
- Safety and Sequential Trials and Tests
- Variations From Normal Testing and Standards

Design Safety Assessment



Aim

- To ensure the design safety principles have been met
- Identify:
 - Failure Modes
 - Interface Problems
 - Hazards to Personnel
 - Technical Risk

Strength of Design



- Firing Test
- Trundling Test
- Special Testing for Airborne and Shipborne Mountings
- User Testing Representing the Most Severe In-service Usage

Safety Assessment Phases



- Phase 1. Design Safety Assessment
- Phase 2. Manned Firing Clearance Assessment
- Phase 3. Safety and Suitability for Service Trials and Assessment

Phase 1 - Design Safety **Assessment**



Conduct Initial Design Safety Assessment

Consider Evidence From:

Fault Tree Analysis (FTA)

**Failure Modes, Effects and Criticality
Analysis (FMECA)**

**Assess Results From Development and Other
Trials**

Phase 2 - Manned Firing **Clearance Assessment**



Conduct Safety Trial Programme

Recommendation For:

Manned Firing Clearance (MFC)

Certificate of Clearance for Use (CCU) for
Naval Applications

Service Deviation for Air Applications

Initial User Trials

Phase 3 - Safety and Suitability for Service Trials and Assessment

A trials programme compiled to demonstrate both safety and suitability for service in the specified environment and to address any areas of concern identified in Phases 1 or 2

Typical Test Sequence

- Development Tests
- Initial Safety Tests
- Trundling Trial (if applicable)
- Initial User Trial
- Main Safety and Technical Tests (including sequential and environmental)
- Main User Trial

Safety Trial - Initial Test

Cannon



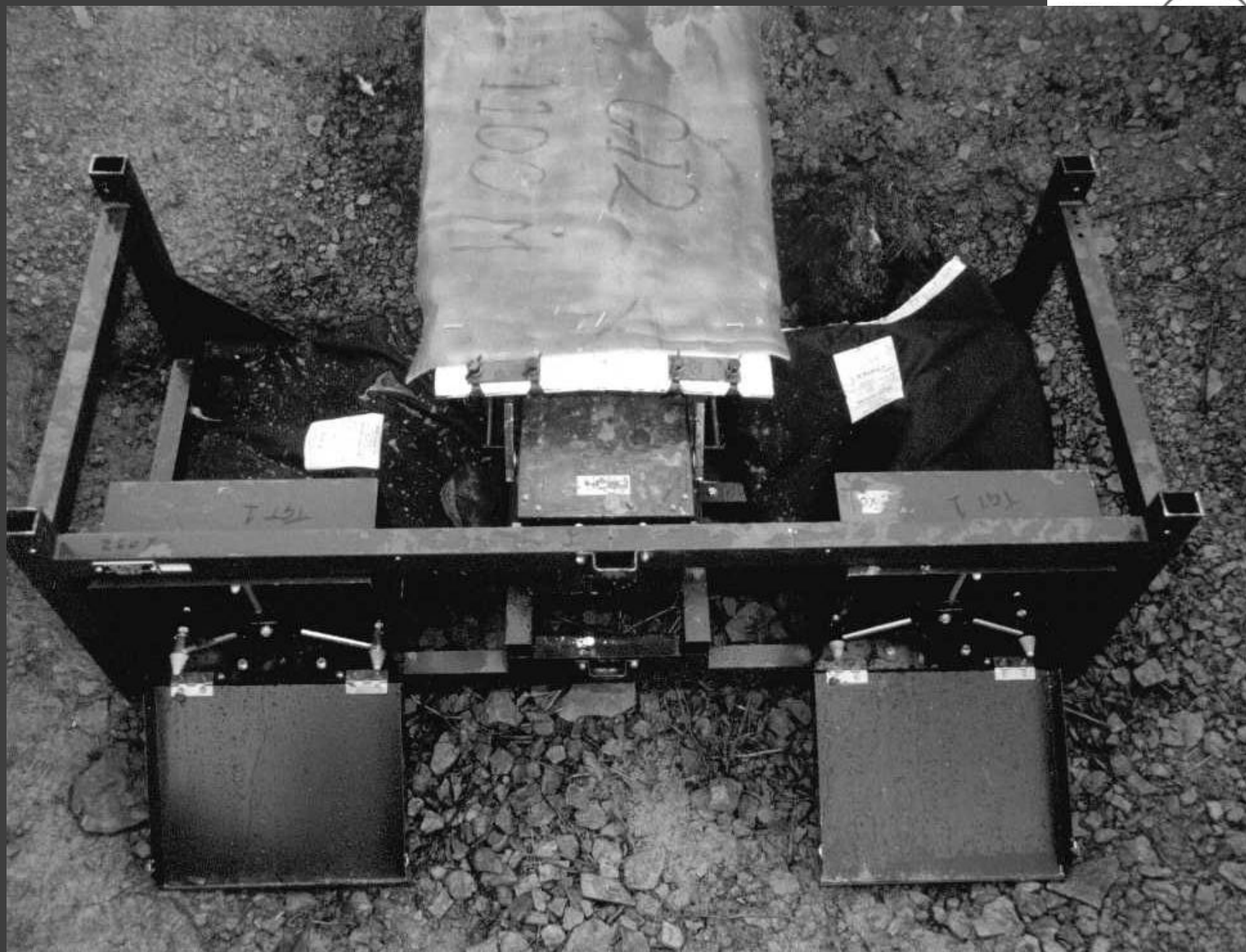
- **2 Service Rounds at Zero Elevation.**
- **2 Proof Rounds at Zero Elevation.**
- **2 Service Rounds at Maximum Depression.**
- **2 Service Rounds at Maximum Elevation.**
- **2 Service Rounds at Zero Elevation.**
- **6 Service Rounds at Zero Elevation (Max Cyclic).**
- **16 Service Rounds at Selected Traverse, Elevation and Depression Positions at Which Firing Arc and Depression Stops Are Applied**

Main Safety Firing Test Cannon

- 200 Service Rounds at Varying Angles of Elevation and Depression
- To Be Fired at the Specified Maximum Rate of Fire.

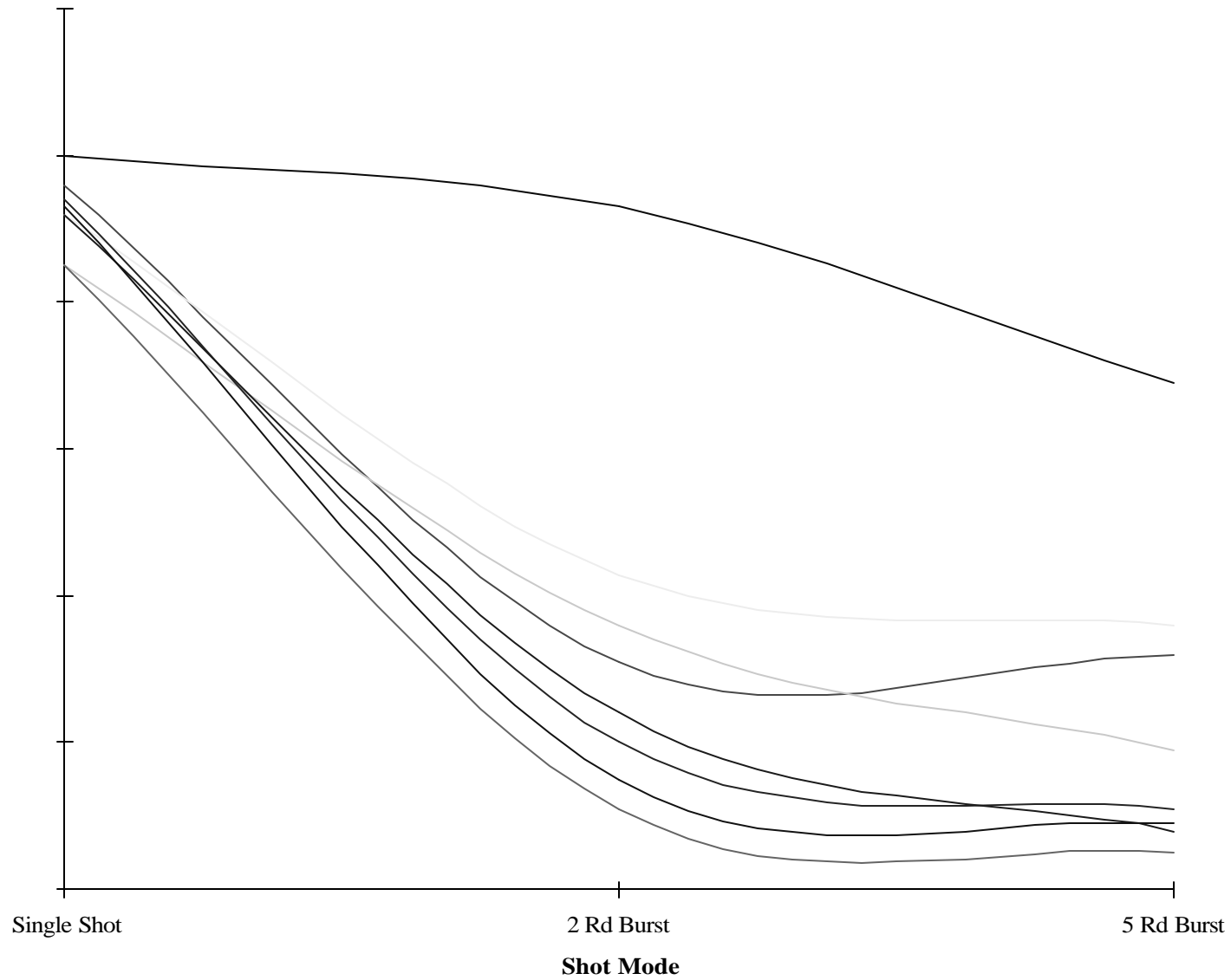
Technical Tests

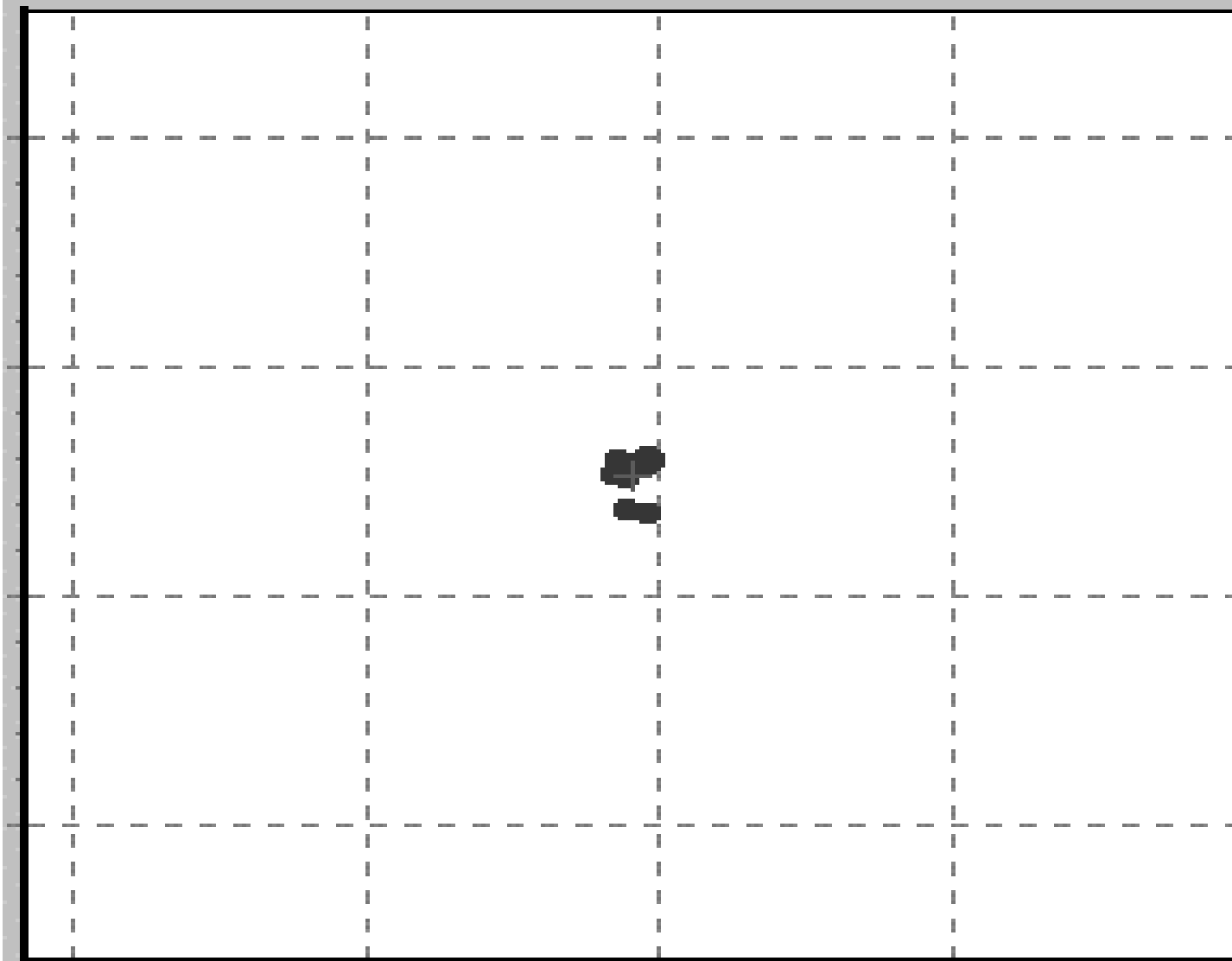
- **Environmental**
- **Consistency**
 - All natures
 - Different modes of fire
 - Different Mount Orientations
- **Accuracy**
- **Functional and Mechanical Reliability**
- **Preliminary Man Machine Interface (MMI)**





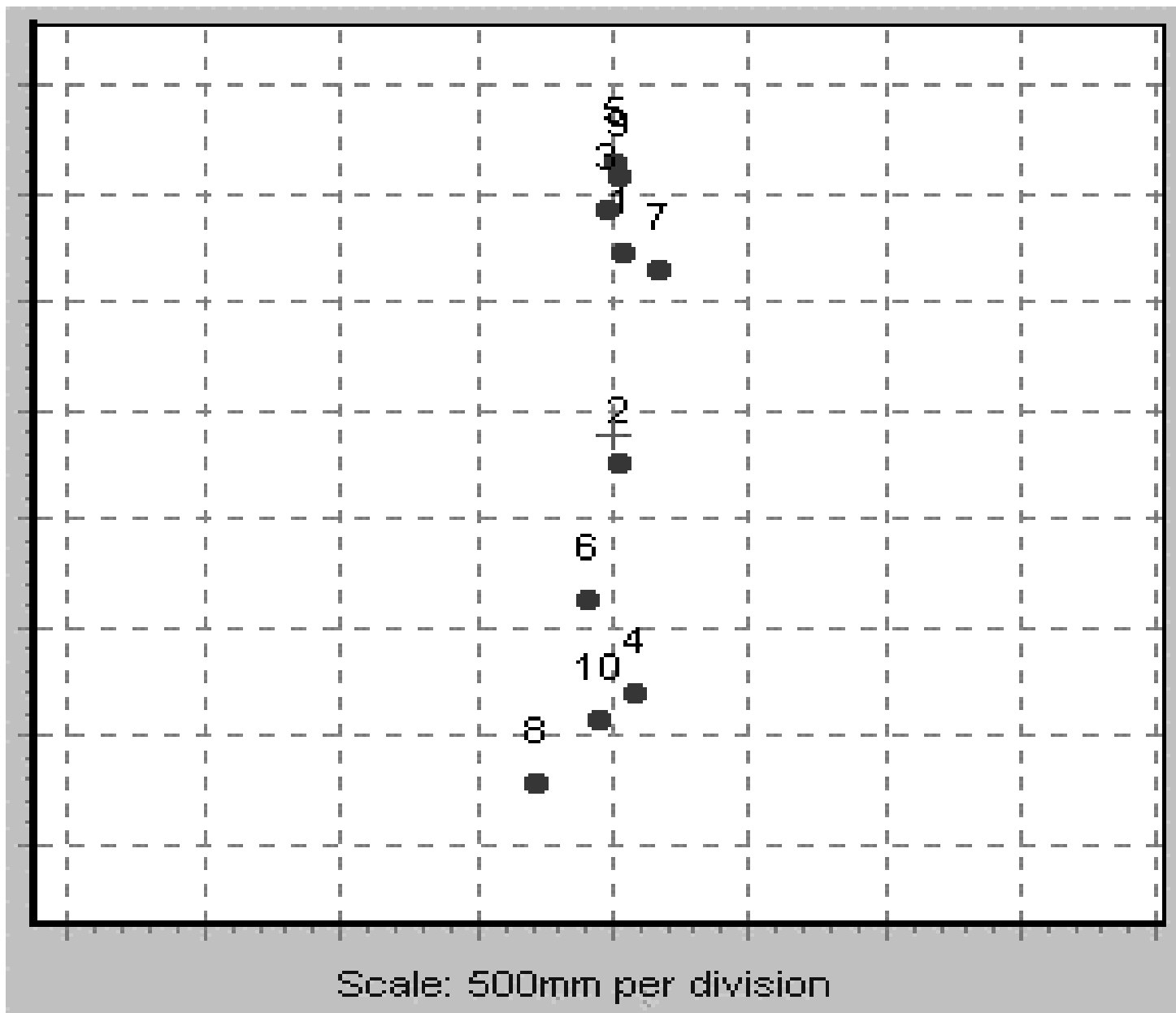
ERROR BUDGET - Probability of a Hit





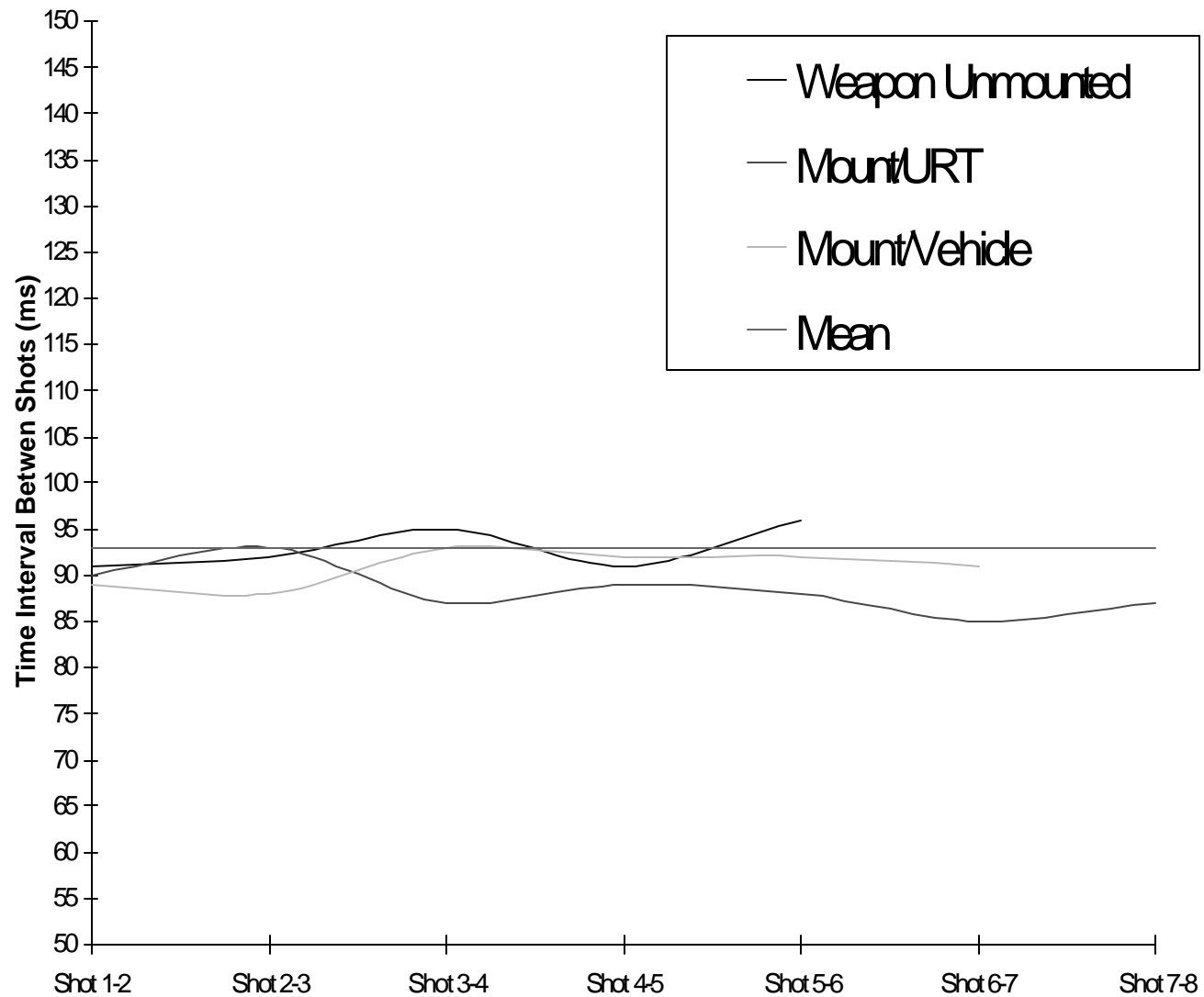
Scale: 500mm per division

Single Shot

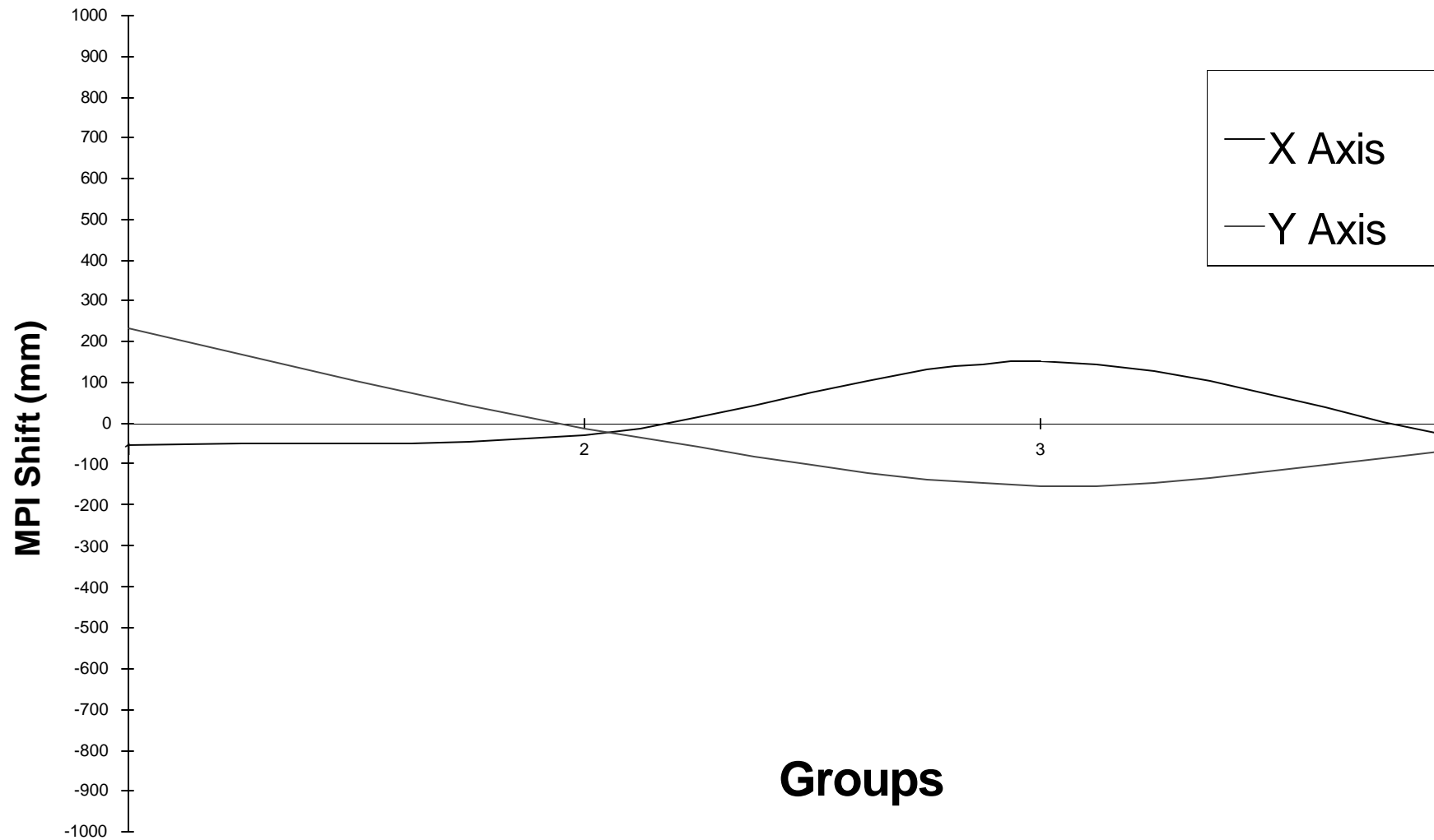


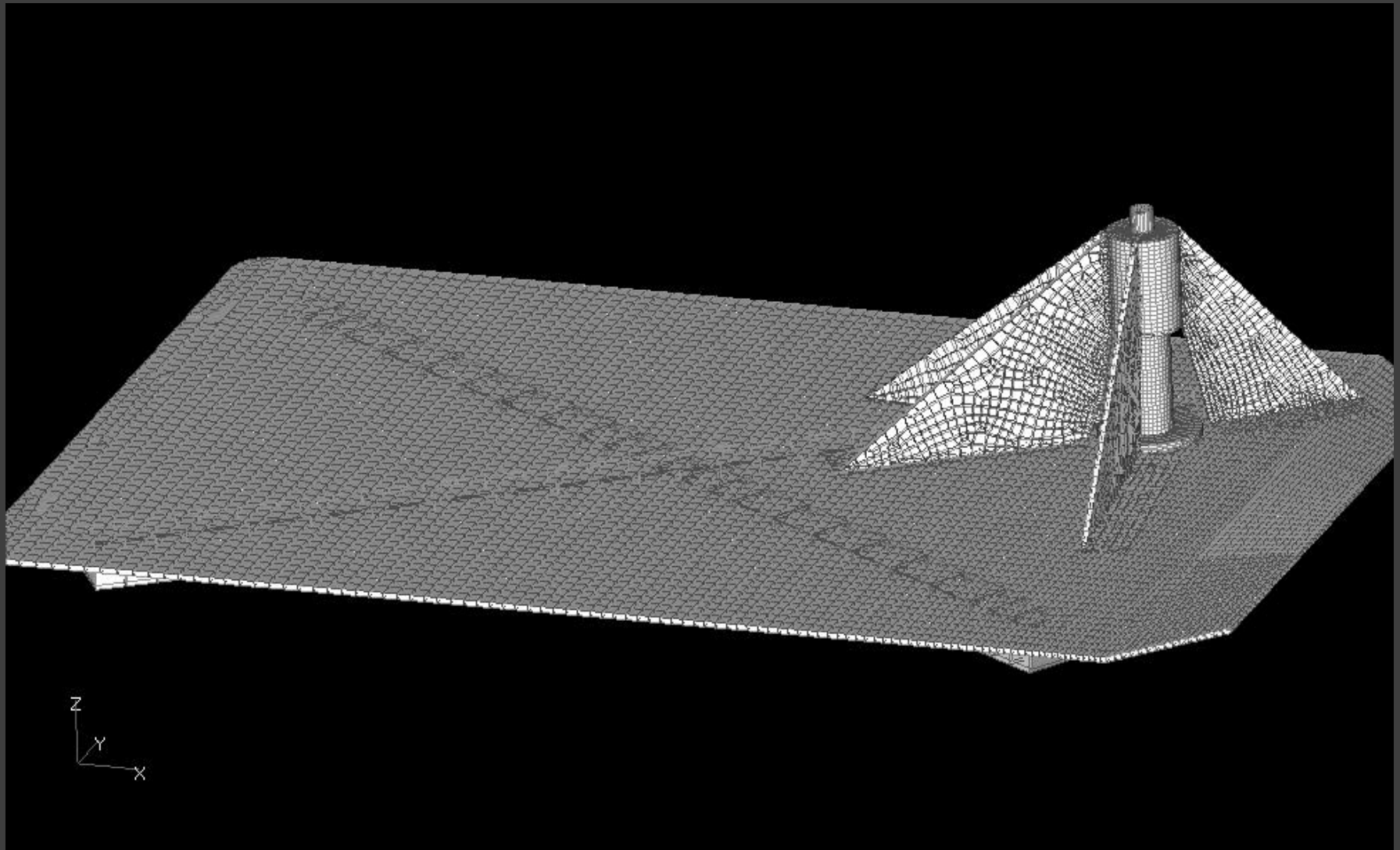
2 Round Bursts

Comparison of Time Intervals Between Shots

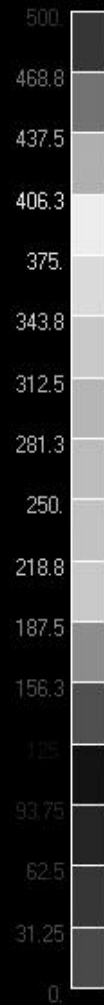
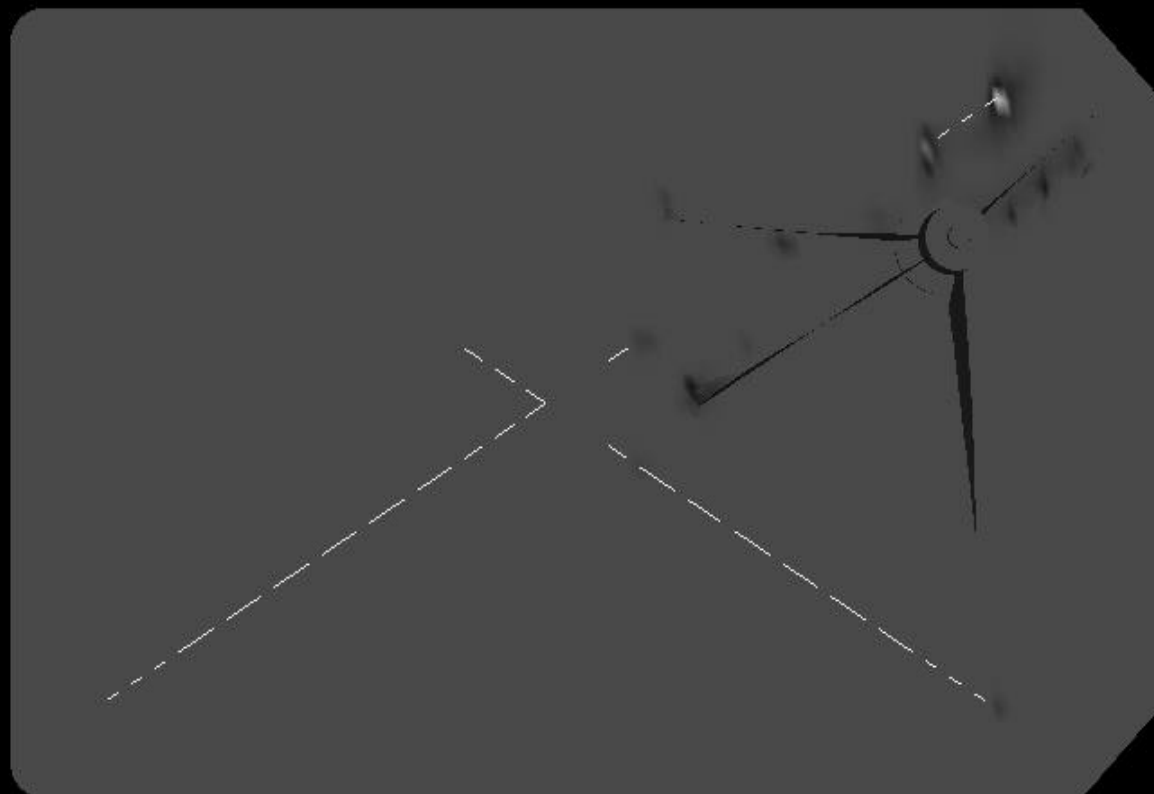


MG Mount - MPI Shift @ 500 m





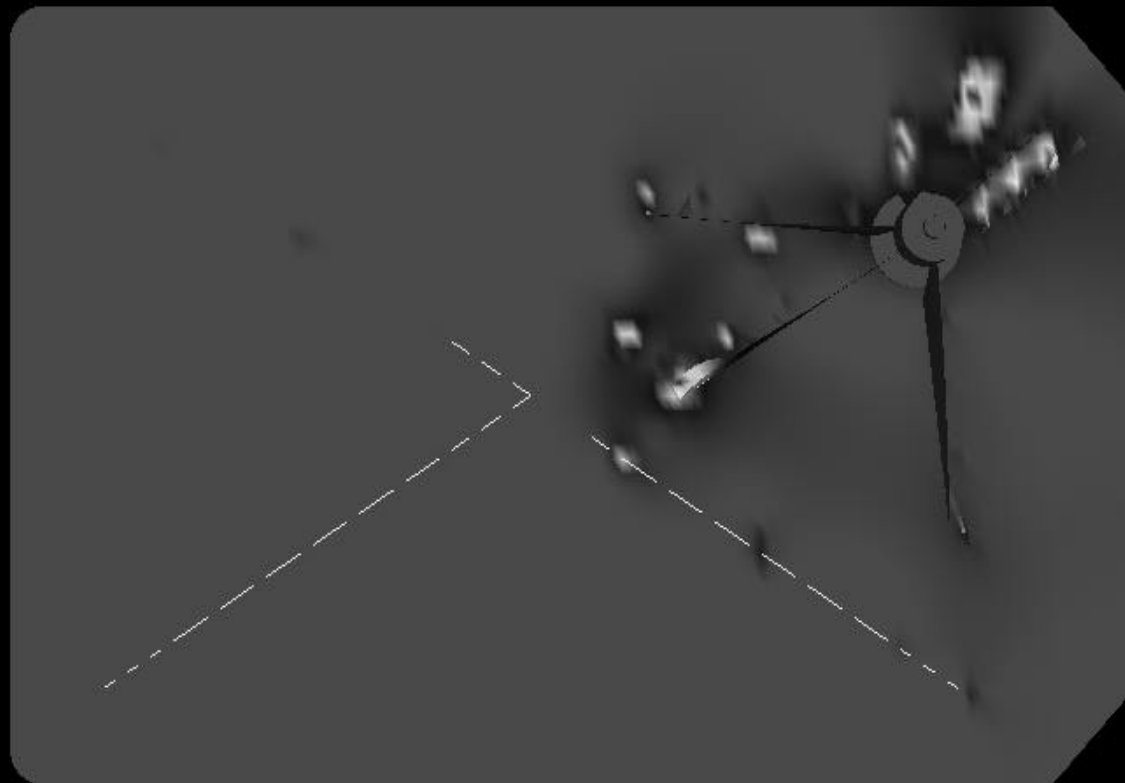
V1
L13
C1
G10



Y
Z
X
Output Set: MSC/NASTRAN Case 4
Deformed(1.259): Total Translation
Contour: Plate Top VonMises Stress

V1
L13
C1
G10

500
468.8
437.5
406.3
375
343.8
312.5
281.3
250
218.8
187.5
156.3
125
93.75
62.5
31.25
0



Output Set: MSC/NASTRAN Case 4
Deformed(4.614): Total Translation
Contour: Plate Top VonMises Stress

Any Questions ?